[

Description] S P E C I F I C A T I O N

[Arrangement and method for forming a total signal, arrangement and method for forming a current signal and a first communication signal, communication system and method for transmitting a first total signal and a second total signal] TITLE

ARRANGEMENT AND METHOD FOR FORMING A TOTAL SIGNAL, ARRANGEMENT AND METHOD FOR FORMING A CURRENT SIGNAL AND A FIRST COMMUNICATION SIGNAL, COMMUNICATION SYSTEM AND METHOD FOR TRANSMITTING A FIRST TOTAL SIGNAL AND A SECOND TOTAL SIGNAL

BACKGROUND OF THE INVENTION

The invention relates to an arrangement and a method for forming a total signal from a current signal and a first communication signal, and to an arrangement and a method for forming a current signal and a first communication signal from a total signal, and also to a communication system and a method for transmitting a first total signal and a second total signal in a communication system.

Such apparatuses and arrangements and also such a communication system are known from [[1]] GB 2 272 350 B. Such an apparatus has a connection at which an electrical total signal can be tapped off. The total signal has a current signal (carrier frequency signal) and an electrical signal which is modulated onto the current signal. The electrical signal modulated on is a communication signal.

A communication signal is to be understood as meaning an electrical signal which permits transmission of electronic data, for example the transmission of textual data, image data or video data.

In principle, any type of modulation can be used for the modulation, i.e. amplitude modulation, frequency modulation or else phase modulation.

This means that, using a normal power supply network supplying an arbitrary number of customers with, by way of example, a three-phase AC voltage at a frequency of 50 Hz, it is also possible to transmit electronic data for communication purposes (communication signal), which permits the use of a power supply network in the field of data transmission.

The apparatus known from [[1]] GB 2 272 3350 B has a coupling element which is coupled to the power supply network. In the coupling element, the communication signal is obtained from the total signal in a first operating mode. In a second operating mode, the communication signal is modulated onto the current signal, thus forming the total signal.

In addition, a second connection is provided which is connected to the coupling element. Depending on the operating mode of the coupling element, the communication signal can be tapped off at or supplied to the second connection.

Thus, a communication signal which is to be modulated and represents the communication data is present on the second connection, or is supplied thereto.

In addition, [[2]] D. Clark, Powerline Communications: Finally ready for prime time?, IEEE Internet Computing, January, February 1998, pages 10-11, 1998 discloses the practice of using such an apparatus in a scenario shown in Figure 2.

Figure 2 shows a power supply network 201 to which a house 202 is connected.

In addition, a base station 203 known from [[3]] Prospectus from the company Northern Telekom und Norweb, Digital Powerline: a major new business

opportunity for power utilities worldwide, Communications Digital Power Line, published March 18, 1998 is connected to the power supply network 201 via an interface 204.

The base station 203 is connected to a communication network 206 via a network interface 205.

The base station 203 has a processor 207 which is connected by means of a bus 208 to data conversion cards 209 (likewise known from [[3]]) Northern Telekom, supra, which, for their part, are connected to the interface 204 by means of coaxial lines 210. In addition, a medium voltage/low voltage transformer element 211 is provided in the power supply network 201.

A medium voltage is to be understood below as meaning a voltage of a few kilovolts (KV), usually 10 KV, and a low voltage is to be understood as meaning a normal operating voltage with a size of approx. 230 V.

The house 202 is connected to the power supply network 201 via a house interface 212.

The house interface 212 is connected to the known apparatus described above, which is denoted by 213 in Figure 2.

The base station 203 modulates a communication signal, called the signal which is to be modulated below, onto a low voltage signal which is transmitted on power lines 214 in the power supply network 201.

The low voltage signal is called the carrier frequency signal below. The carrier frequency signal is usually at 220 V and has a frequency of 50 Hz.

Thus, a first signal 215, comprising the carrier frequency signal 220 and a communication signal 221, which is generated by the base station 203 and is modulated onto the carrier frequency signal, is supplied to the house 202 via the lines 214.

The first signal is supplied to the apparatus 213 described above via the house interface 212.

In the apparatus 213, the carrier frequency signal 220 is supplied to an electric meter 216 in a known manner, and the modulated signal 221, which has been demodulated from the carrier frequency signal, is supplied via a coaxial line 217 to a first computer 218 and to a second computer 219.

A disadvantage of this scenario is that the coaxial cable 217 in each case needs to be laid for each computer unit 218, 219 in the house 202 from the apparatus 213, i.e. new lines need to be laid in the house 202 in each room in which there is a computer, in order to permit data communication via the power supply network 201. This results in considerable additional effort when planning the house 202, and also results in considerable inflexibility for planning and furnishing the house 202.

It is also known practice for the communication signal to be modulated onto the current signal in a frequency range of a few MHZ, usually in the range between 1 MHZ and approximately 8 MHZ.

The reason for limiting the frequency range lies in the attenuation profile of the transmission medium used. At approximately 8 MHZ, the attenuation of the communication signal is so high that it becomes impossible to transmit the communication signal over relatively long distances. To transmit a signal requiring a relatively high bandwidth, a dedicated transmission medium, for example a coaxial cable, is used.

The invention is thus based on the problem of specifying an arrangement and a method for forming a total signal from a current signal and a first communication signal and also an arrangement and a method for forming a current signal and a first

communication signal from a total signal, which arrangement and method achieve a higher level of flexibility for planning and furnishing a house, and also achieve improved use of bandwidth.

The invention is also based on the problem of specifying a communication system and a method for transmitting a first total signal and a second total signal in a communication system, which communication system and method achieve a higher level of flexibility for planning and furnishing a house, and also achieve improved use of bandwidth.

[The problem is solved by the arrangements and methods in accordance with the features of the independent patent claims.] A method is provided for forming an overall signal from a current signal in at least one of a first communication signal with first payload data that require a large first bandwidth in transmission and a second communication signal with second payload data differing from the first payload data that require a smaller second bandwidth compared to the first bandwidth. The first communication signal is modulated onto the current signal in a first frequency range and the second communication signal is modulated onto the current signal in a second frequency range. The first frequency range at least partially comprises a frequency range of frequencies higher than the second frequency range. The modulation of the first communication signal occurs in the first frequency range such that a quality of the first payload data does not fall below a predetermined quality given a transmission of the current signal with the first communication signal modulated thereonto via a first transmission path in the energy supply network.

An arrangement for forming a total signal from a current signal and a first communication signal comprises the following features:

a) a first connection, to which the current signal can be supplied,

b) a second connection, to which the first communication signal can be supplied,

c) a total connection, at which the total signal can be tapped off,

d) a coupling element for forming the total signal from the current signal and the first communication signal, which coupling element is coupled to the first connection, to the second connection and to the total connection, and

e) the coupling element being set up such that, when forming the total signal for the first communication signal, a first frequency range is provided, and for a second communication signal, which second communication signal can be modulated onto the current signal, a second frequency range is provided, at least part of the first frequency range comprising a frequency range of [higher] frequencies higher than the second frequency range.

An arrangement for forming a current signal and a first communication signal from a total signal comprises the following features:

a) a first connection, at which the current signal can be tapped off,

b) a second connection, at which the first communication signal can be tapped off,

c) a total connection, to which the total signal can be supplied,

d) a coupling element for forming the current signal and the first communication signal from the total signal, which coupling element is coupled to the first connection, to the second connection and to the total connection, and

e) the coupling element being set up such that, when the first communication signal is formed, a first

frequency range is provided and a second frequency range is provided for a second communication signal, which second communication signal can be modulated onto the current signal, at least part of the first frequency range comprising a frequency range of higher frequencies than the second frequency range.

A communication system having a first communication unit, a second communication unit and a power supply network which provides a current signal has the following features:
a first frequency range is provided for a first communication signal, which is formed by the first communication unit and is added to the current signal in order to form a first total signal, and
a second frequency range is provided for a second communication signal, which is formed by the second communication unit and is added to the current signal in order to form a second total signal,
at least part of the first frequency range comprises a frequency range of higher frequencies than the second frequency range.

In a method for forming a total signal from a current signal and a first communication signal, when forming the total signal for the first communication signal, a first frequency range is provided, and for a second communication signal, which second communication signal can be modulated onto the current signal, a second frequency range is provided, at least part of the first frequency range comprising a frequency range of higher frequencies than the second frequency range.

In a method for forming a current signal and a first communication signal from a total signal, when the first communication signal is formed, a first frequency range is provided and a second frequency range is provided for a second communication signal, which second communication signal can be modulated onto the current signal, at least part of the first

frequency range comprising a frequency range of higher frequencies than the second frequency range.

A method for transmitting a first total signal and a second total signal in a communication system having a first communication unit, a second communication unit and a power supply network which provides a current signal comprises the following features:

- the first communication unit forms a first communication signal, which is added to the current signal in order to form a first total signal,
- a first frequency range is provided for the first communication signal in the first total signal,
- the first total signal is transmitted to the second communication unit,
- the second communication unit forms a second communication signal, which is added to the current signal in order to form a second total signal,
- a second frequency range is provided for the second communication signal in the second total signal,
- the second total signal is transmitted to the first communication unit, and
- at least part of the first frequency range comprises a frequency range of higher frequencies than the second frequency range.

The invention can clearly be regarded as the communication signal's being modulated onto the current signal in a frequency range which, at least in part, contains frequencies which are higher than the frequencies of the frequency range in which the communication signal has been transmitted previously. In this context, it has been recognized that, particularly in the case of a relatively large house with a plurality of residential units, within each residential unit, a distance needs to be bridged between the residential unit's respective connection to the power supply network and a computer unit which is short enough for the attenuation [not yet] to be not

too high [enough for] which would prevent transmission of the communication signal [not to be possible after all].

In this way, a higher level of flexibility for planning and furnishing a house and also optimized use of available bandwidth are achieved.

[Preferred developments of the invention can be found in the dependent claims.

]Preferably, the second communication signal is modulated onto the current signal in the second frequency range.

In addition, the arrangements in one development are provided with a modulation/demodulation unit which is coupled to the total connection and can be used to modulate the first communication signal and/or the second communication signal onto the current signal, thus forming the total signal, or can be used to demodulate the first communication signal and/or the second communication signal from the current signal.

The modulation/demodulation unit is preferably coupled to an electrical appliance, and the electrical appliance may be a computer (computer unit).

An illustrative embodiment of the invention is shown in the figures and is explained in more detail below.

[In the figures] BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a sketch of a conversion unit based on the illustrative embodiment;

Figure 2 shows a sketch of a power supply network having a base station and a house, connected to the power supply network, with an apparatus based on the prior art;

Figure 3 shows a sketch of a power supply network having a base station and a house, connected to the power supply network, with an apparatus based on the illustrative embodiment; and

Figure 4 shows a sketch of a graph used to describe an attenuation profile for the frequencies

used for modulating the second communication signal 401 and the first communication signal 402.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the preferred embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Like Fig. 2, Fig. [Like Figure 2, Figure] 3 shows, using the same reference symbols for the same components, the base station 203 connected to the power supply network 201 via the interface 204. In addition, the house 202 is connected to the power supply network 201 via the house connection 212.

[Figure] Fig. 3 shows the house 202 with a first residential unit 301 and a second residential unit 310. The first residential unit 301 contains a first computer 302, and the second residential unit 310 contains a second computer 311.

The first computer 302 is connected by means of a communication cable 303 to a first modulation/demodulation unit 304, described below. A second power cable 305 connects the first modulation/demodulation unit 304 to a first conversion unit 306, which is likewise described below.

The second computer 311 is connected by means of a third power cable 312 to a second modulation/demodulation unit 313 (described below), the second modulation/demodulation unit 313 being in the same form as the first modulation/demodulation unit 304. A fourth power cable 314 connects the second modulation/demodulation unit 313 to a second conversion

unit 315 (which is likewise described below), the second conversion unit 315 being in the same form as the first conversion unit 306.

The design of the first conversion unit 306, 100 is shown in [Figure] Fig. 1.

The first conversion unit 306, 100 has a first connection 101, at which a current signal 102 can be supplied or tapped off, depending on the operating mode. In a first operating mode, a second communication signal is modulated onto the current signal 102 as a carrier frequency signal.

In the first operating mode, communication (described below) takes place from the first computer 302 to the power supply network 201 and the communication network 206.

In a second operating mode, the communication (described below) takes place from the power supply network 201 and the communication network 206 to the first computer 302.

In addition, the first conversion unit 306, 100 has a second connection 103, at which a first communication signal 104 can be supplied or tapped off, depending on operating mode.

The first conversion unit 306, 100 also has a total connection 105, at which a total signal 106 can be supplied or tapped off, depending on operating mode.

In the first operating mode, the total signal 106 contains the current signal 102 as carrier frequency signal, and also the second communication signal, modulated onto the current signal 102. The second communication signal is modulated onto the current signal 102 in a second frequency range of approximately one to approximately four-eight MHZ.

[Figure] Fig. 4 shows a sketch of a graph 400 used to describe an attenuation profile 403 for the modulation frequencies of the second communication signal 401 and of the first communication signal 402 with rising frequency 404.

The attenuation is described in the unit of decibels (dB).

The graph 400 shows the transmission properties of the power distribution network 201, 305, 314 in the frequency range, where the relatively long distances in the network 201 mean that only modulation frequencies of up to approximately 1 to 8 MHZ can be used for the second communication signal 401 on account of the attenuation, and, furthermore, a second communication signal can no longer be transmitted. Over a relatively short distance, for the distance from the first conversion unit 306 or from the second conversion unit 315 to the first computer 302 or to the second computer 311 within the context of this illustrative embodiment, modulation frequencies of up to approximately 20 to 30 MHZ can be used, which means that there is much more bandwidth available for the first communication signal 402. This is described by the attenuation profile for

the first communication signal 402. In this case, the attenuation first increases in a range of approximately 10 to 20 MHZ, and only at 20 MHZ does it become so high that the modulation frequencies of the first communication signal 401 can no longer be transmitted.

The range from approximately 10 to 20 Mbps (Megabit per second) is called the first frequency range below.

On the basis of this knowledge, the first conversion unit 306 is set up such that, in the second operating mode, the total signal 106 has the current signal 102 as a carrier frequency signal and the first communication signal 402, 104, which is modulated onto the current signal 102.

The first communication signal 402, 104 is modulated onto the current signal 102 in the first frequency range, i.e. the first communication signal 402 is transmitted within a residential unit using a respective frequency range containing frequencies which are higher than the frequencies in the second frequency range.

This achieves optimized utilization of available bandwidth.

The first conversion unit 306 also has a coupling element 107 coupled to the first connection 101, to the second connection 103 and to the total connection 105.

The coupling element 107 contains a circuit arrangement 108 which is set up such that, in the first operating mode, the first communication signal 104, 402 is modulated onto the current signal 102 in the first frequency range, thus forming the total signal 106.

In addition, the coupling element 107 is set up such that, in the second operating mode, the second communication signal 401, which is modulated onto the current signal 102 in the second frequency range, is supplied via a network to a converter/demodulator unit 203 which is connected to the central connection 320.

In the central connection 320, the first communication signal 402 and the second communication signal 401 are combined in a manner known per se and are supplied to the communication network 206.

The rest of the explanations clarify the interaction of the individual components further.

It is assumed that the first computer 302 transmits a request message 330 using the Transport Control Protocol/Internet Protocol (TCP/IP). The request message 330 is used to request information from the Internet, which is the form taken by the communication network 206. The request message 330 is supplied to the first modulation/demodulation unit 304. In the first modulation/demodulation unit 304, the request message 330 is modulated as second communication signal 401 onto the current signal 102, thus forming the total signal 506. The modulation is effected in the second frequency range.

The total signal 106 is supplied via the second power cable 305 to the total connection 105 of the first conversion unit 306, 100 by the first modulation/demodulation unit 304.

Within the context of this first operating mode, the first conversion unit 306, 100 connects the total signal 106 to a first connecting cable 340, which is connected to a power supply network as shown in Figure 2, via the first connection 101 as current signal 102 with the second communication signal 401 modulated [on] <u>thereon</u>, and transmits it within this power supply network as second communication signal modulated onto the current signal. Arranged within this power supply network is a device 203 which demodulates the second communication signal, modulated onto the current signal, and supplies the request message 330 to the central connection 320.

In the central connection 320, which can be situated at an arbitrary point in the power supply

network, the request message 330 is supplied to the communication network 206.

Connected to the communication network 206 are further computers 360, 361, 362, 363, ...

The request message 330 is transmitted to the further computer 360, 361, 362, 363 to which it has been directed on the basis of the unique Internet address (IP address), in this example to a first further computer 360, which is set up as an Internet server.

Once the request message 330 has been received, the first further computer 360 forms a response message 370 containing the information requested by the first computer 302.

The first further computer 360 transmits the response message 370 to the first computer 302. The response message 370 is supplied to the central connection 320 via the communication network 206.

Within the context of this second operating mode, the response message 370 is supplied from the central connection 320 via a second connection cable 350 to the first conversion unit 306, which is likewise connected to the second connecting cable 350, as first communication signal 402.

In the first conversion unit 306, the first communication signal 402 is modulated onto the current signal 102, thus forming the total signal 106.

The first communication signal 402 is modulated in the first frequency range.

The total signal 106 is supplied to the first modulation/demodulation unit 304. In the first modulation/demodulation unit 304, the response message 370 is demodulated from the total signal 106 as first communication signal 402 and is supplied to the first computer 302.

[An] <u>One</u> alternative <u>among many</u> to the illustrative embodiment <u>is as follows.</u> [portrayed above is illustrated below:

] The communication protocol used for transmitting the digital data may be any desired communication protocol, i.e. the method and arrangements are not limited to the communication protocol based on the TCP/IP standard.

[The following publications were cited within the scope of this document:] While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirt of the invention are desired to be protected

ABSTRACT OF THE DISCLOSURE

[An arrangement]In an arrangement and method for forming a total signal [from], an arrangement and method for forming a current signal and a first communication signal, and a communication system and method for transmitting a first total signal and a second total signal, [When] when forming the total signal for the first communication signal, a first frequency range is provided[, and for]. For a second communication signal, which second communication signal can be modulated onto the current signal, a second frequency range is provided [at] . At least part of the first frequency range [comprising] comprises a frequency range of higher frequencies than the second frequency range.